THE LUBBOCK SNOWSTORM OF FEBRUARY 20, 1961

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ABSTRACT

Twenty inches of snow fell in the Lubbock, Texas area on February 20, 1961 in a surprise storm which left many motorists stranded. The storm is reviewed to try to determine if the storm could have been forecast with any degree of reliability. The use of Jacobson's /2/ steps, Henry's /3/ rule and the snow vs rain rules by Wagner /4/ and Younkin /5/ would have indicated snow for the area a few hours in advance. Forecasting the storm depended on the ability to forecast the upper low accurately. Although no new rule is offered here, some interesting observations of the upper low and corresponding 200 MB charts are made. This storm is compared to the snowstorm of February 1-5, 1956, in New Mexico and Texas as reported by Brown and Brintzenhofe /1/.

1. INTRODUCTION

Snow began falling in southeastern New Mexico during the early morning of February 20, 1961 and spread into the Lubbock, Texas area before noon. By the time the snowfall ended about midnight, an area about 100 miles wide and 200 miles long was covered with 6 inches or more of snow with greatest depth of 20 inches near Lubbock (figure 1). Hundreds of cars were abandoned and some students were forced to spend the night at school. School buses started taking students home at noon but did not complete the task until 9 PM. Residents had little or no warning of the storm. The first mention of snow was in the 4:10 PM forecast of the 20th.

The facsimile data from the surface to 200 MB have been reviewed to determine if there were any parameters that would have indicated such a storm. The data are accepted as received although it is realized that errors in analysis might exist, particularly over Mexico where little or no data are available. The storm was caused by an upper low that moved over the area and stagnated for a few hours. Forecasting the movement of the low was the major problem with a secondary problem of whether precipitation would be rain or snow. Objective rules for development and movement by Jacobson /2/ and Henry /3/ and for snow vs rain by Wagner /4/ and Younkin /5/ are applied to this storm with generally favorable results.

2. SURFACE CHART AND WEATHER

The snowstorm was highly localized considering that none accumulated on the ground beyond 75 miles to the north and south nor beyond about 120 miles to the east and west of the maximum snow depth. Snow fell northward to Amarillo, Texas but melted as it fell. Precipitation was in the form of rain on the south and east sides of the storm. The storm was similar to that of the snowstorm of February 1-5, 1956 in New Mexico and Texas as reported by Brown and Brintzenhofe /1/. The 1961 storm did not last as long nor was it as widespread, but the accumulation was more rapid. Surface temperatures in this storm were generally in the lower 30's as compared to the middle 20's in the storm of 1956. Little or no drifting was reported in this storm while strong winds and much drifting were reported in the 1956 storm. The surface chart at 12Z February 20, 1961 (figure 2) was very much like the surface chart in the 1956 storm, the main differences being that the earlier storm had a 1048 MB high over the Great Basin and considerably stronger gradient was over western Texas. The Great Lakes high was missing from the earlier storm. The frontal pattern and the Mexico low were nearly identical.

The 12 hour surface pressure change offered little or no clue to the snowfall. A 4 MB fall area moved southward from western Nebraska on the 19th to western Texas on the 20th. These falls had little effect on the flow pattern. The precipitable water over the area was generally about one third inch with only minor variations throughout the period.

3. 850 MB AND THICKNESS CHARTS

The 850 MB chart has been selected to emphasize the problem of rain versus snow (figure 3). Note that a small area of below freezing temperatures was over the South Plains of Texas and southeastern New Mexico and easterly winds indicated warm advection for the area. One would expect the warm advection to be sufficient to cause precipitation to fall as rain but vertical motion, orographic lifting and cooling by evaporation apparently were enough to offset the warm advection. Vertical motion over the area was computed by NMC to be positive at 00Z February 20th and was forecast to remain positive for the next 24 hours, however, these forecasts were several hours old by the time they were received.

The 700 MB chart was essentially the same as the 500 MB chart. Coldest temperatures (minus ten degrees C) were near the center of the low. Wagner /4/ uses a thickness between 1000 and 500 MB to determine whether the precipitation will be snow or rain. For elevations similar to that in the Lubbock area, a thickness of 17,900 feet or less will produce snow. The 1000-500 MB thickness over the area was 18,000 ft and a small area of thickness of 17,800 ft was centered about 50 miles east of El Paso at 12Z February 20th (figure 2). Less thickness is required for lower elevations and this probably explains why snow did not occur in the lower plains east of Lubbock. Younkin /5/ gives some preliminary data on the 850-700 MB thickness for snow over the eastern U. S. The layer maximum thickness for snow is 5110 ft and the minimum for rain is 5010 ft. The 850-700 MB thickness over the high plains and southeastern New Mexico was less than 5100 feet with a small area of less than 5000 feet located east of El Paso at 12Z February 20th. Assuming slightly greater thickness for higher elevations, snow would have been indicated.

4. 500 MB ANALYSIS

At 500 MB the closed low moved from Utah into Mexico and curved sharply eastward to west Texas and stagnated for a few hours (figure 4). This was remarkably similar to the 1956 storm. Another problem in an accurate forecast of the snowstorm would have been an accurate forecast of the 500 MB low. The forecast positions of the 500 MB low by various forecast centers are shown in figure 4. This figure is not intended to compare the forecast but to point out that most forecasts: (1) failed to indicate the rapid recurvature, (2) placed the center too far south after recurvature, and (3) failed to indicate the stagnation over western Texas. The barotropic prog consistently kept the low and positive vorticity advection area too far west. This was probably due to a lack of data from Mexico and other sources which have largely been corrected since the date of this storm. The Baroclinic package was received too late to be of practical value at that time but it is also vastly improved and is very timely now. However, there are times when the two NMC products are not in full agreement and some decision must be made as to which is superior. Some of the following discussion is directed toward that end.

The winds ahead and behind the trough were about 50 knots. The air over Nevada was cold and the Jacobson steps /2/ were completed. (Step 1, the 500 MB wind at Seattle and/or Tatoosh had a northerly component which was retained through the entire period. Step 2, the 500 MB temperature at Medford had fallen to minus 25 degrees C or lower and Step 3, the temperature at Ely or Las Vegas had fallen to minus 25 degrees C or lower attended or shortly followed by a distinct temperature rise at Medford. Jacobson states that these steps assure necessary amplitude and southward extension and eastward motion of the trough to effect and promote a distinctly favorable area of cyclogensis in the region of southeastern Colorado.) By 12Z February 19th a small low had formed over south central Arizona with lowest height of 18,000 feet. Three hundred-foot 12 hour height rises were over southern Nevada while El Paso reported a 140 ft fall. Largest fall was 280 ft at Tucson. Continuity showed that the center was moving south-southeastward about 25 knots. By 00Z February 20th the low had recurved to a few miles south of the Arizona-New Mexico border with continuity indicating a movement of east-southeast about 20 knots. With the exception of a slight fall at Tucson, all observations within the general area showed height rises. The low had filled to about 18,200 feet. Winds over eastern Arizona had changed to more northeasterly and were from about 20 degrees approximately 60 kt. The 500 MB low moved to about 30 miles east of El Paso by 12Z on the 20th (figure 6) and to a point about midway between Midland and Lubbock by February 21st where it stagnated for about 12 hours before moving northeastward. The use of Henry's Rule /3/ for moving the low eastward would have left considerable doubt in the forecaster's mind, as there was a katallobaric center about 1200 miles northwest of the low when it recurved, but it was weak. The rule, however, applied satisfactory to the low after it stagnated over western Texas. It is noted that there were no height falls within 1200 miles west or northwest of the low when it stagnated, but the low moved northeastward as soon as vigorous height falls were within 1200 miles northwest of the low. The Jacobson steps did alert forecasters to the possibility of heavy snow but later developments led them to believe that this would be one of the few times that the steps would fail. This opinion was easy to obtain when the 500 MB low cut off, and no signs of surface development appeared.

5. 200 MB AND MAXIMUM WIND CHARTS

The 200 MB chart was similar to the maximum wind chart in respect to winds. Temperatures at 200 MB offered no clues. Warmest temperatures were in the trough. Height changes at this level did seem to have some relationship to the storm. Height falls (12 hour) of 150 to 240 feet dominated all the western half of the United States except height rises of about 300 feet over the state of Washington on the 12Z February 18th chart. The 12 hour height changes on the 00Z February 19th chart were rises of 200 to 600 feet over Montana, Washington, Oregon, and northern California with slight falls from North Dakota to southern Arizona. By 12Z February 19th slight height falls were over southern Arizona and southern New Mexico and rises elsewhere over the western U. S. except another fall area had entered Washington. On the 00Z chart of the 20th most changes were rises but the change at El Paso was zero and the impulse over Washington 12 hours previous could be traced from near Oakland northeastward by slight rises or falls compared to 200 ft rises either side. By 12Z February 20th the impulse was from Yuma northeastward through Grand Junction with weak falls from that area eastward to central Texas and central Oklahoma. It is believed that this impulse at 200 MB caused the 500 MB low to stall for about 12 hours as they became in phase. The 200 MB height falls moved on eastward as the 500 MB low renewed its northeasterly movement.

A correlation between the wind shear at the 200 MB level (or jet level) and the 500 MB low is also noted. The 500 MB low advanced in 12 hours about to the area of maximum wind shear at the jet level. Note the packing of the isotachs over southern Arizona at 00Z February 19th (figure 7) and the position of the 500 MB low at 12Z on the 19th and 00Z on the 20th (figure 4). The eastward progression of the jet and therefore of the area of maximum wind shear was considerably less on the 12Z February 20th chart (figure 8) and possibly a signal that the 500 MB low would temporarily stall. The maximum shear along with cyclonicly curved contours is a rough approximation of the positive vorticity maximum at the jet level and apparently the subsequent height falls at 500 MB. This maximum may be placed subjectively at 12Z February 20 between the Texas Big Bend and El Paso, immediately upstream from Lubbock (figure 8). Studies of additional 500 MB lows suggest that (1) with shear northwest of the low near the same magnitude, the low will dig southward or remain stationary and (2) eastward moving lows frequently move faster than the shear zone indicates because the shear zone itself is moving eastward. This can be determined from continuity of the jet analysis. These characteristics are sometimes used as a bias when the barotropic and baroclinic progs differ.

CONCLUSIONS

An accurate forecast of a snowstorm of such magnitude would be very difficult. However, the main characteristics for these storms appear quite similar. These characteristics are (1) arctic air or very cold air well into the gulf and backed along the eastern slopes of the Rockies, (2) a closed low at 700 or 500 MB moving over the area, (3) an easterly component of low level wind, i.e., upslope, and (4) a thickness or forecast thickness low enough for snow (about 17,800 ft or less between 1000 and 500 MB. These characteristics can all be easily recognized but determining the exact location of the outbreak of heavy snow more than a few hours in advance is very difficult.

REFERENCES

1. Brown, H. E. and Brintzenhofe, R. A., "Snowstorm of February 1-5, 1956, in New Mexico and Texas", Monthly Weather Review, February 1956, pp 75-85.

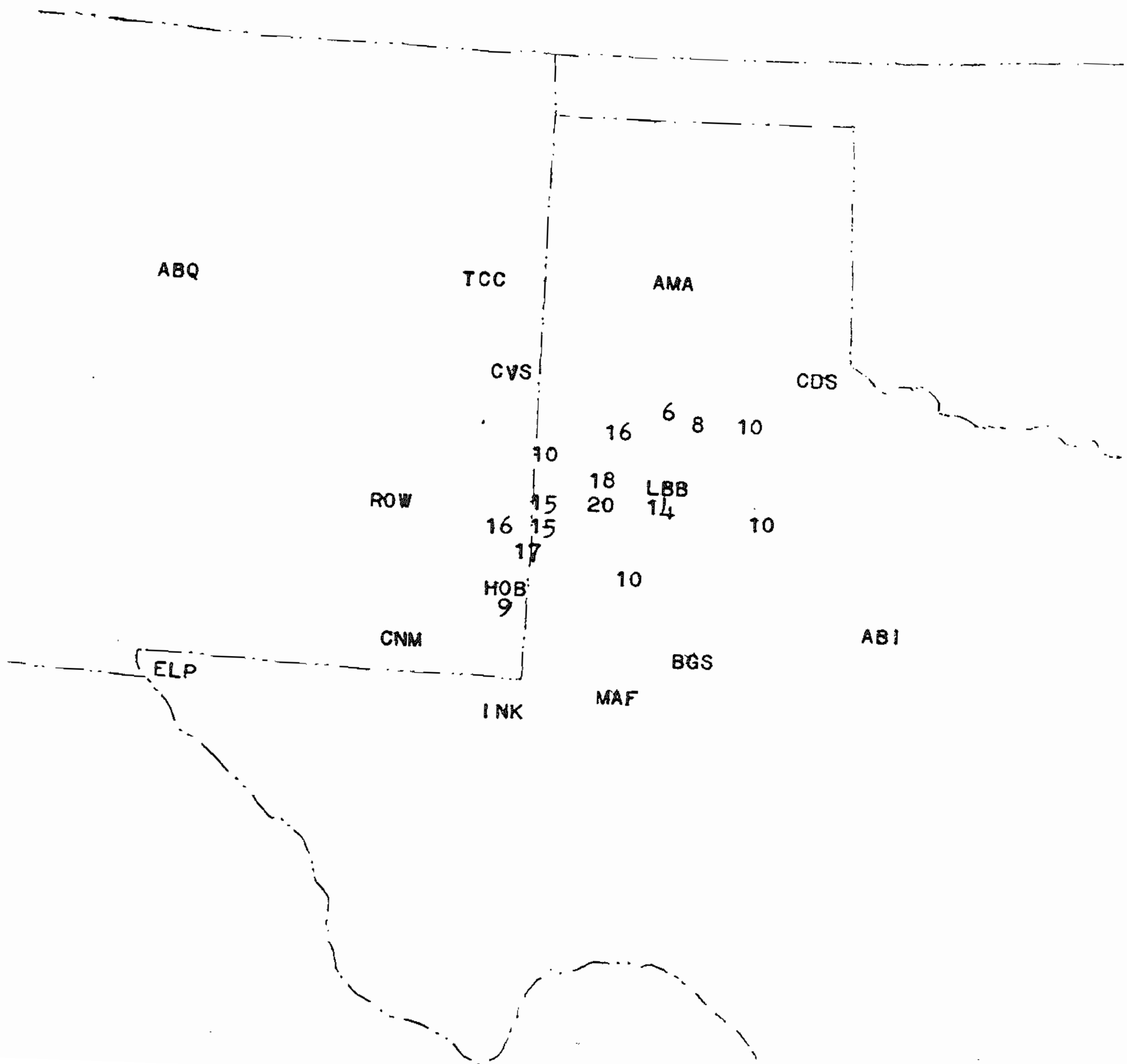
2. Jacobson, H. L., Sanders, R. A., and Hanson, D. M., "The Central High Plains Storm of November 1-3, 1956", Monthly Weather Review, November 1956, pp 401-14.

3. Henry, W. K., 1949 Master's Thesis, Department of Meteorology, University of Chicago (available from Weather Bureau Library, Washington, D. C.)

4. Wagner, A. J., "Mean Temperature from 1000 MB to 500 MB as a Predictor of Precipitation Type", Bulletin of A.M.S., Vol. 38, No. 10, December 1957.

5. Younkin, R. J., "1000-850 MB and 850-700 MB Thickness-Precipitation Type Relations", Unpublished research report, U. S. Weather Bureau, Alcoa, Tennessee, 6 pp. (available from Weather Bureau Library, Washington, D. C.)

Figure 1. Area of reported snow depth in inches.



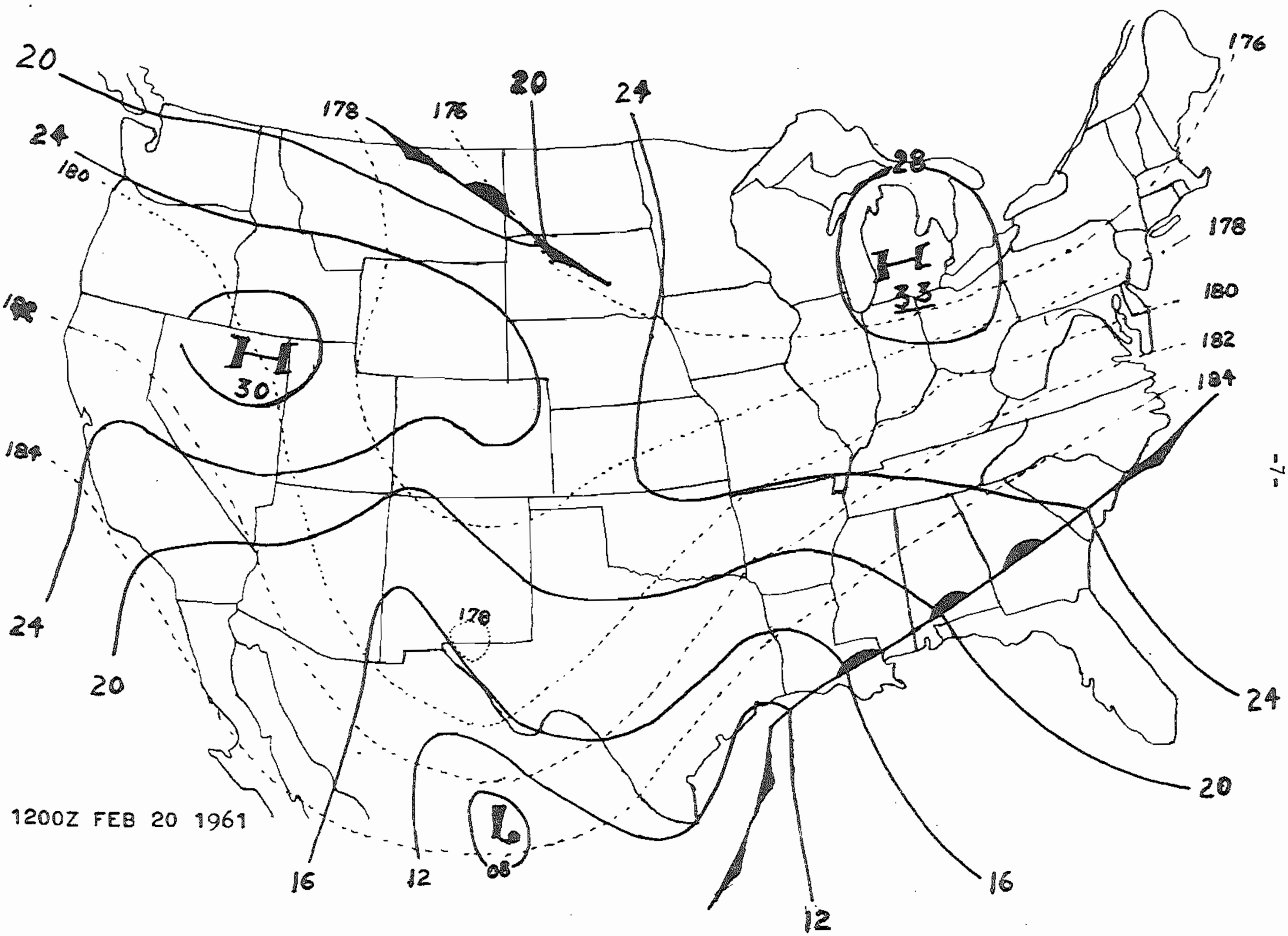
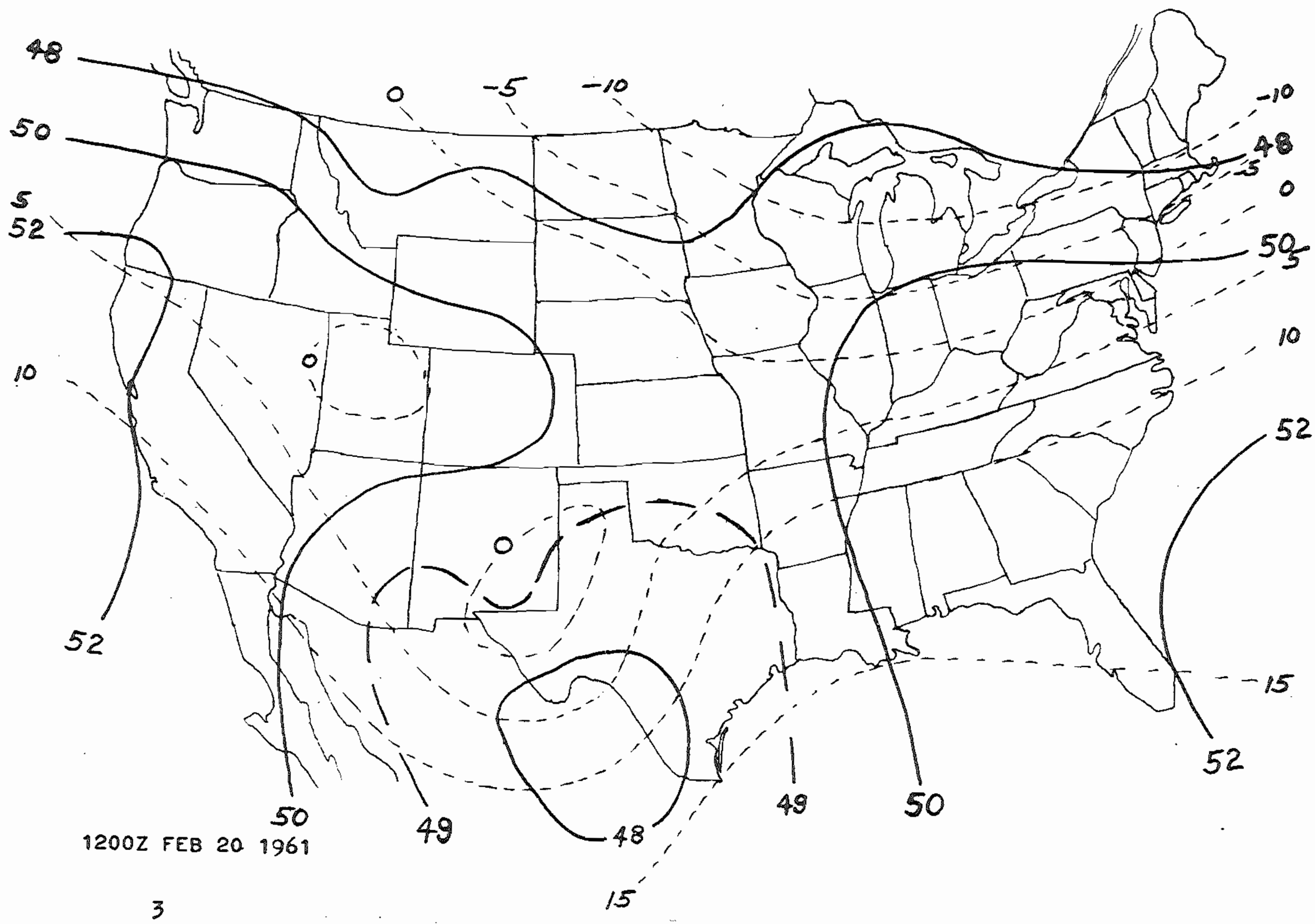


Figure 2. Surface map for 1200Z February 20, 1961 using standard symbols and 1000-500 MB thickness (dashed lines) labeled in hundreds of feet.

Figure 3. 850 MB chart for 1200Z February 20, 1961 using standard symbols.



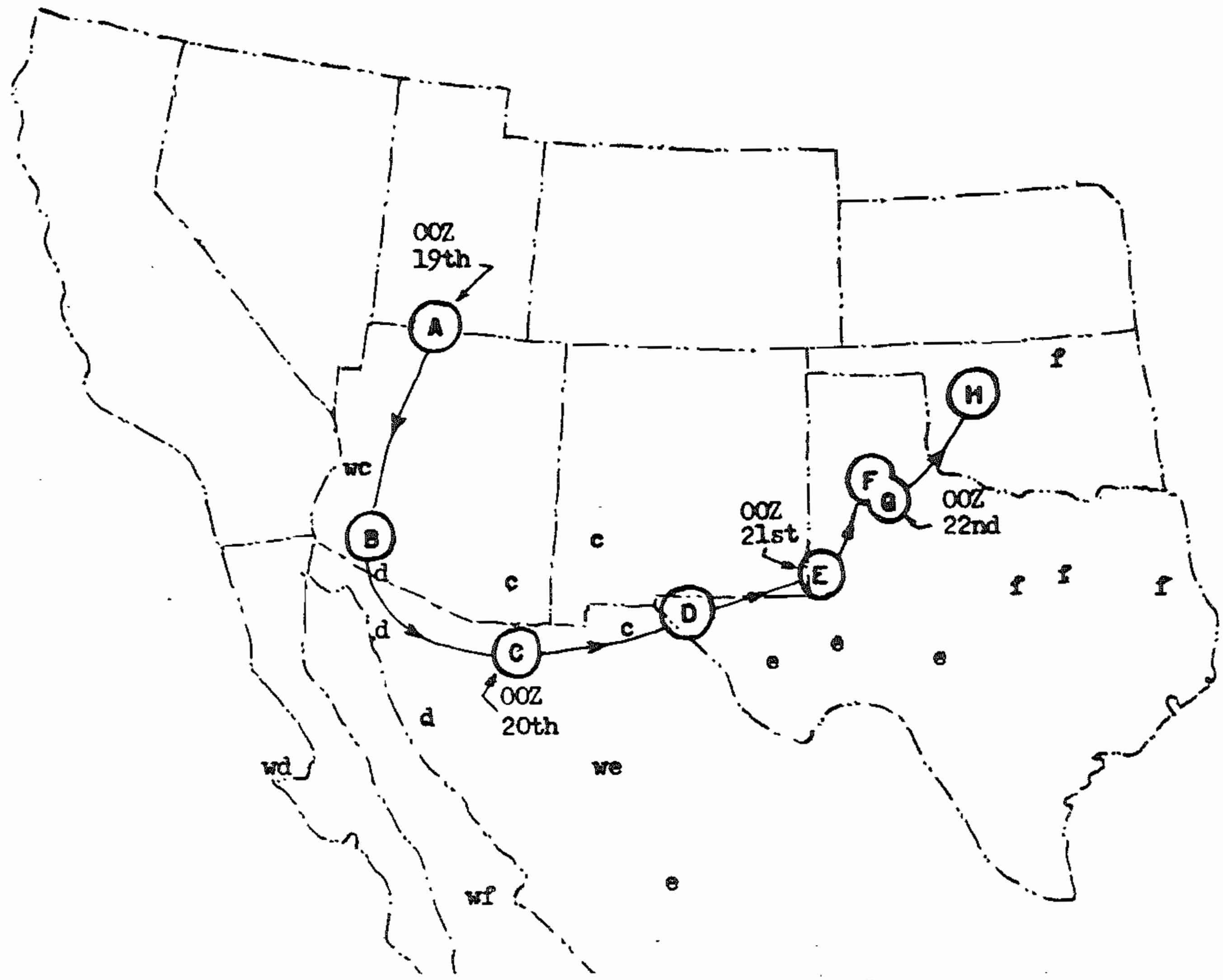
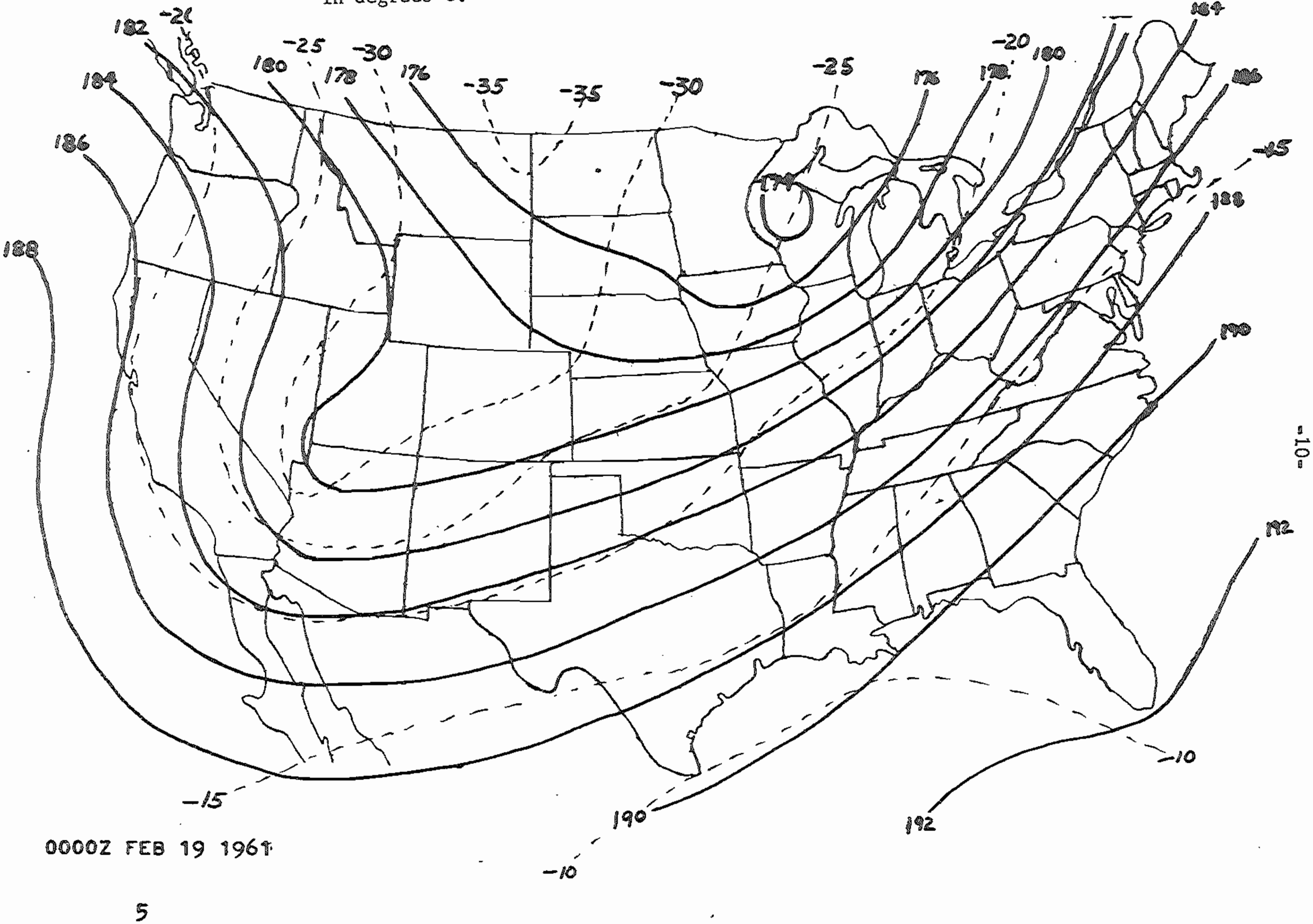


Figure 4. Observed positions of 500 MB low each 12 hours. Twenty-four hour forecast positions by various forecast centers are shown in small letters with verifying time corresponding to capital letters. Letters with prefix "w" are 36 hour barotropic prog positions verifying at time of corresponding capital letters.

Figure 5. 500 MB chart for 0000Z February 19, 1961. Solid lines are height contours in hundreds of feet. Isotherms (dashed) are labeled in degrees C.



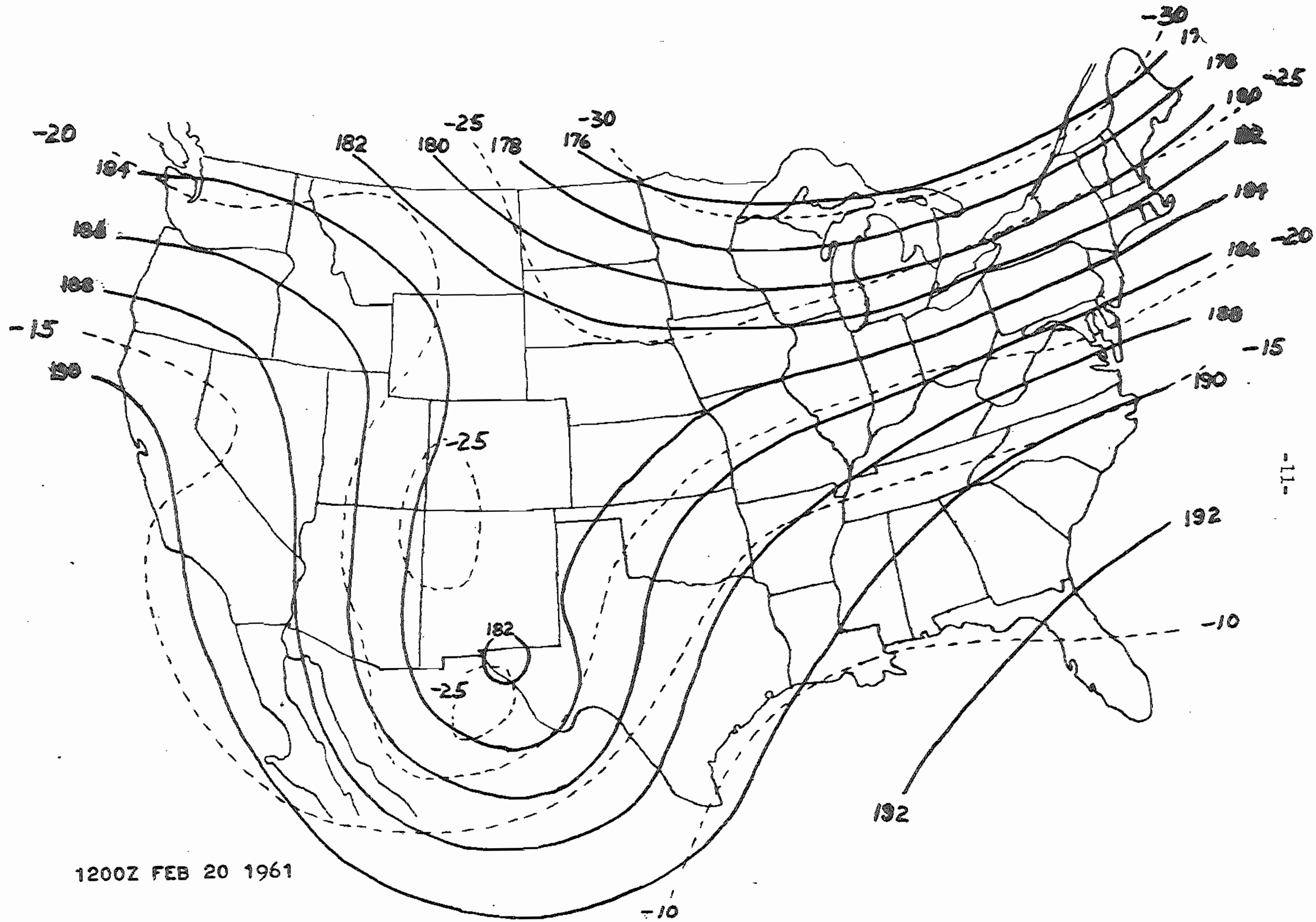
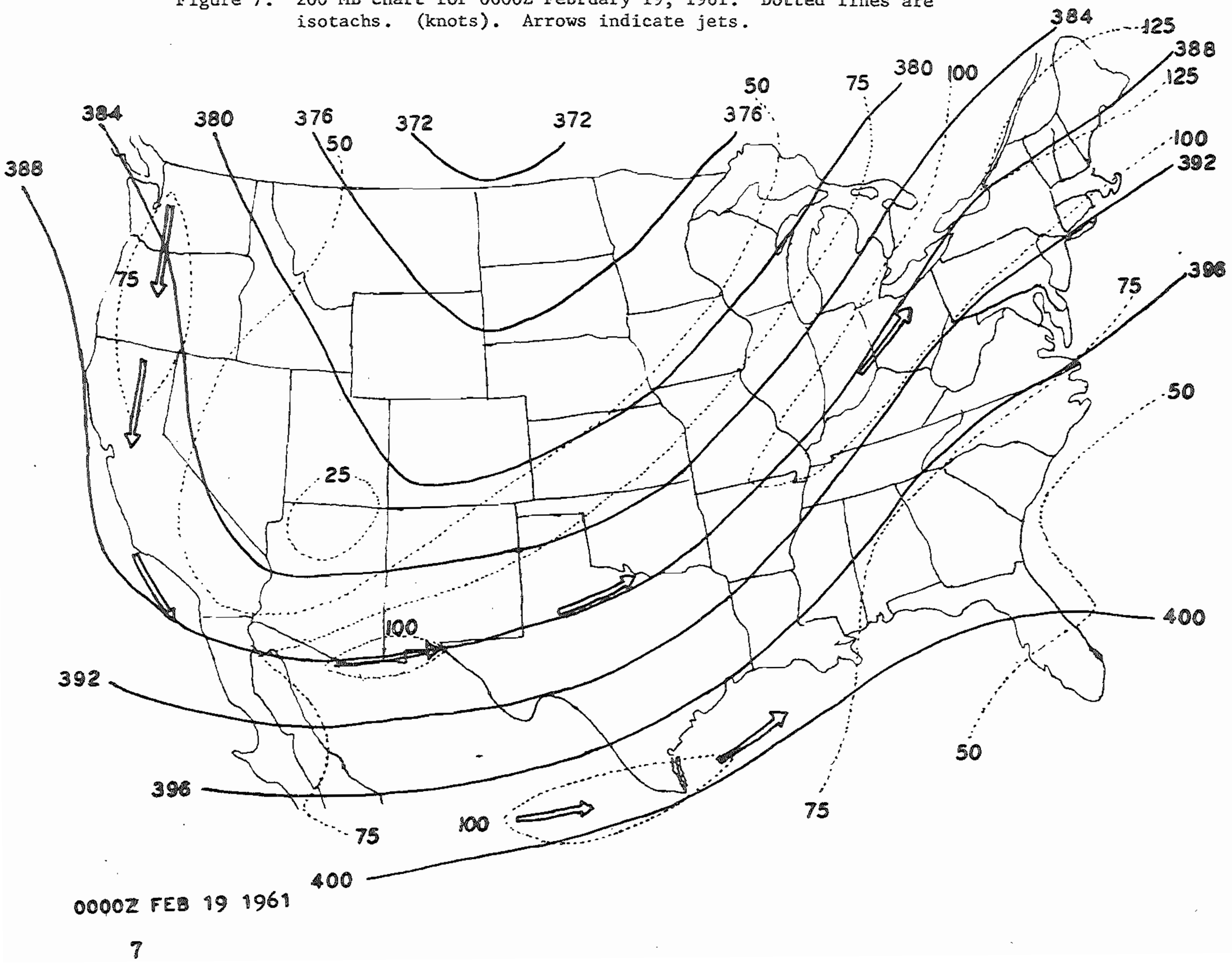


Figure 6. 500 MB chart for 1200Z February 20, 1961.

Figure 7. 200 MB chart for 0000Z February 19, 1961. Dotted lines are isotachs. (knots). Arrows indicate jets.



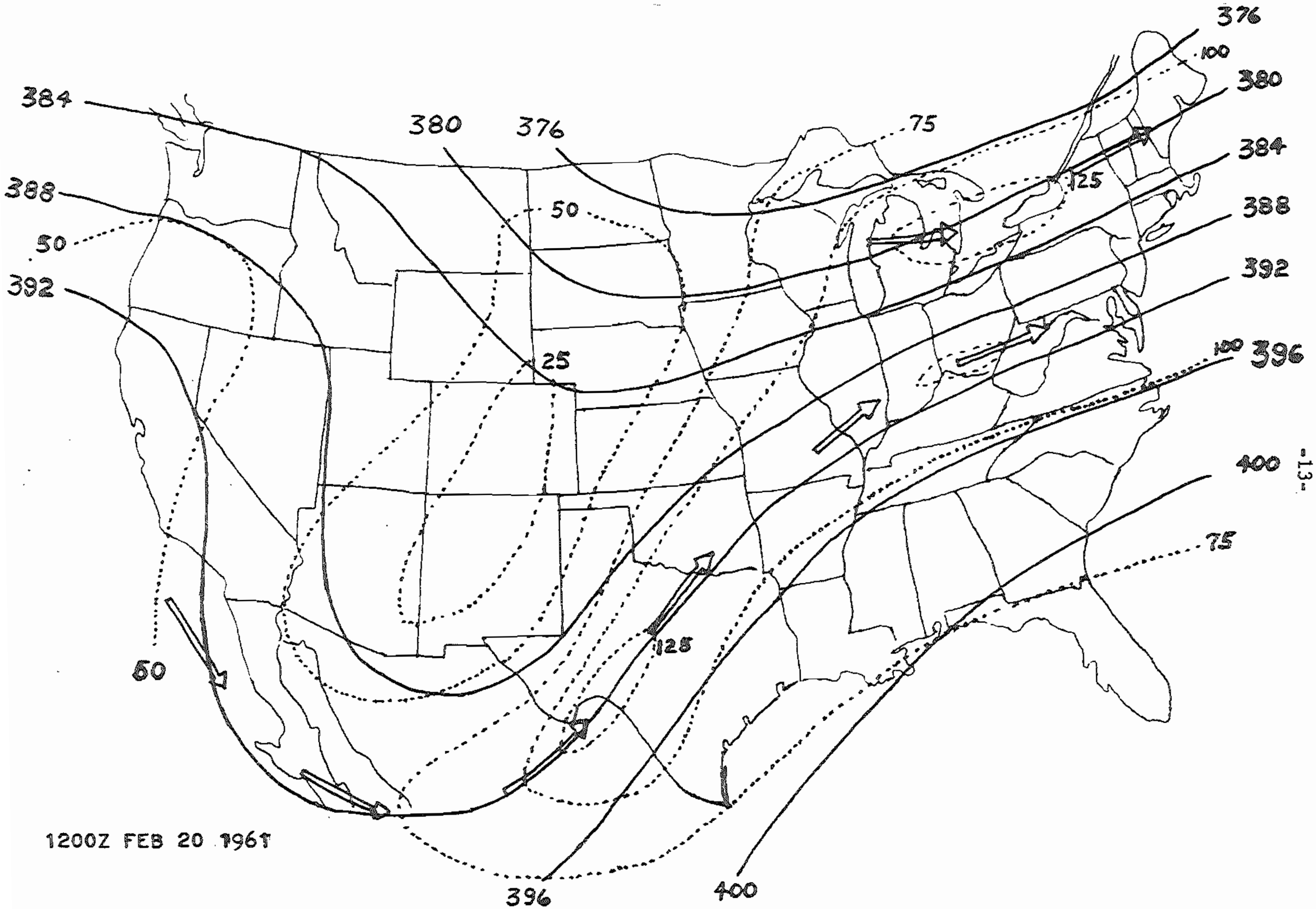


Figure 8. 200 MB chart for 1200Z February 20, 1961.